Treatment of equine leg wounds using skin grafts: Thirty-five cases, 1975–1988

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Abstract

A retrospective study was conducted on 35 equine patients with lower leg wounds that were managed utilizing skin graft procedures. Two pinch graft, five punch graft, seven tunnel graft, eight split-thickness mesh graft and thirteen full-thickness mesh expansion graft procedures were performed in the initial treatment. The average wound size was 188 cm^2. Twenty-four cases had pregrafting complications: 10 wounds developed sequestra; three wounds were grossly contaminated and infected; and 11 cases developed granulation tissue complications prior to grafting. Graft failure following the initial procedure was seen in 12 cases and occurred with all techniques except pinch grafting. Graft failure was often attributable to poor quality of granulation tissue as well as anatomic site, especially the dorsal surface of the tarsus. An average of two additional grafting procedures was required to successfully treat initial failures. Pinch grafts took the longest time to epithelialize (70 days), followed by punch grafts (47 days). Both were similar in terms of being the least durable and least cosmetically acceptable of all techniques used. Split-thickness and full-thickness mesh expansion grafts were technically the most difficult, but showed the most rapid epithelialization (28 days), greatest durability, and the best cosmetic appearance. Tunnel grafts provided a practical technique for grafting cases which were either not suited for, or which had failed with, mesh expansion grafts.

Résumé

Traitements par greffes cutanées de plaies situées aux extrémités chez les équins

Étude rétrospective effectuée sur 35 chevaux présentant des plaies cutanées aux extrémités, lesquelles furent traitées par des greffes de peau. Les procédures chirurgicales utilisées comme traitement initial comprennent 2 greffes par pincement, 5 par poinçon, 7 par formation d'un tunnel, 8 par transfert de lambeaux à épaisseur partielle et 13 par transfert de lambeaux pleine épaisseur créés par expansion. L'étendue moyenne des plaies était de 188 cm^2. Vingt-quatre cas présentèrent des complications avant toute procédure de greffes: 10 plaies ont développé des séquestres, 3 plaies étaient grossièrement contaminées et infectées et 11 plaies ont développé des complications reliées au développement du tissu de granulation.

Le rejet de la greffe suite au traitement initial s'est produit dans 12 cas, répartis dans toute la gamme des techniques utilisées, à l'exception de la greffe par pincement. Le rejet fut souvent attribué à un tissu de granulation de pauvre qualité et au site anatomique, spécialement à la surface dorsale du tarse. En moyenne, deux autres techniques de greffe ont été requises pour traiter avec succès les échecs initiaux. Le temps d'épithélialisation fut de 70 jours pour la greffe par pincement et de 47 jours pour la greffe par poinçon. Ces deux techniques ont fourni les résultats les moins favorables tant au point de vue de l'aspect esthétique que de la résistance. Les transferts des lambeaux à épaisseur partielle et à pleine épaisseur créé par expansion ont été plus dificiles à effectuer, mais ont démontré un temps rapide d'épithélialisation (28 jours) et les meilleurs résultats tant au point de vue de l'aspect esthétique que de la résistance. La technique de greffe par formation d'un tunnel demeure un autre choix valable pour les cas ne se prêtant pas à la greffe par expansion ou lors d'un précédent échec.

(Traduit par Dr Thérèse Lanthier)

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Introduction

Wounds to the lower limb of the horse are seen frequently by equine practitioners in western Canada. Wounds with extensive soft tissue trauma and skin loss have a tendency to produce exuberant granulation tissue which can be difficult to manage. Skin grafting techniques have been developed and utilized to encourage rapid healing and to produce a more functional and cosmetically acceptable scar. The nature of the wound and the type of graft used are important factors in determining the final outcome. The skin grafting techniques most commonly reported in horses are pinch and punch grafts (1,2), tunnel grafts (3,4), and full- and split-thickness mesh expansion grafts (5–11). While the application of these procedures is well described, there is a lack of studies comparing these techniques in terms of their practicality, limitations, and long-term success.

The purpose of this study is to present follow-up on a group of 35 equine cases in which pinch, punch, tunnel, split-thickesss mesh expansion, and full-thickness mesh expansion grafts were used in the treatment of lower leg wounds.

Materials and methods

Case records of wounds involving skin grafting procedures performed at the Western College of Veterinary Medicine between 1975 and 1988, inclusive, were reviewed. Follow-up information was obtained through telephone conversation with owners or re-examination of the patients. Case records were reviewed and the

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Table 1. Summary of skin graft results

	Punch	Pinch	Tunnel	Full-thickness mesh	Split-thickness mesh	Mean or ratio of all techniques	SE
Number of cases	5	2	7	13	8		
Average wound size (cm^2)	258	128	167	159	241	188	23
Range	(150–500)	(105–500)	(50–420)	(100–300)	(49–600)		
Average age of wound at admission (days)	11	8	16	55	26	31	7
Range	(0–28)	(2–14)	(0–28)	(0–180)	(0–42)		
Time from admission to 1st graft (days)	26	51	25	32	36	32	5
Range	(9–49)	(46–56)	(4–60)	(3–137)	(8–104)		
Pregrafting complications (# complications/total cases)	3/5	1/2	6/7	6/13	8/8	24/35	
Success at first grafting/ total cases	4/5	2/2	4/7	9/13	4/8	23/35	
Success at subsequent grafting/number of attempted grafting/procedures[a]	1/1	1/1	7/12	1/3	0/3	10/20	
Time from grafting to discharge (days)	47	70	34	28	28	36	4
Range	(20–57)	(28–96)	(19–54)	(11–66)	(17–49)		

[a]Selection of subsequent graft techniques for unsuccessful cases was based on the technique which would optimize success and not specifically a repeat of the original grafting procedure

data evaluated and summarized. The objective variables included: wound location and size; age of the wound upon admission; time from admission to first grafting; skin grafting technique used; and the time from skin grafting to discharge. Wound location was listed anatomically and an estimate of wound size was based on the measurement of the width and length of the wound. The data were statistically evaluated using a graphics software program (Stat Graphics, STSC Inc., Rockville, Maryland, USA). Subjective variables included: associated complications prior to grafting, success of skin grafting, and long-term cosmetic and functional evaluation.

The complications were categorized according to their description in the medical records. Success of the skin graft was a subjective assessment involving degree of contraction and epithelial cover of the wound. Long-term evaluation was done by owner's descriptions, or follow-up examinations.

Results

Thirty-five cases were admitted for skin grafting procedures during the 13 year investigation period (Table 1). Thirty-three of these wounds were located on the hindlimb. There were 8 tarsal wounds, 21 metatarsal wounds, and 4 involving both the tarsus and metatarsus. The two forelimb wounds involved the metacarpus in one case and the distal antebrachium in the other. One case was admitted for cosmetic revision of a six-month-old scar and was not included in the calculations of average age at admission or average age at grafting. The average size of one wound in the split thickness category and one wound in the punch graft category could not be accurately determined from the medical record.

Twenty-four cases had pregrafting complications. Ten metatarsal wounds developed sequestra and nine required sequestrectomy. Three wounds appeared grossly infected, having mucopurulent discharge at presentation. Granulation tissue complications in the form of exuberant tissue or the presence of clefts and fissures developed in 11 wounds. In total, 20 of the 24 cases that were presented with complications required surgical treatment under general anesthesia prior to grafting.

Graft failure occurred in 12 cases following initial grafting, and was seen with all techniques except pinch grafting. The average size of the wounds that failed was 135 cm^2. Five of the 12 graft failures were associated with tarsal wounds and one involved both the tarsal and metatarsal regions. Eight of the graft failure cases had pregrafting complications. Of these, five cases required surgery for granulation bed complications and three cases required sequestrectomy prior to grafting. The remaining 4 of the 12 cases of initial graft failure (three full-thickness mesh expansion and one tunnel graft) failed for no apparent reason.

In total, 55 grafting procedures were performed on the 35 cases presented. Those cases which failed following first grafting were subsequently treated with either the same grafting procedure or an alternative method. An average of two additional grafting procedures was required to achieve a successful outcome.

Thirty-three of the 35 cases were considered successful at discharge, based on the observation that the

grafts were stable and healthy. Many of the wounds were only partially epithelialized at discharge. Long-term follow-up was available on 28 of the 33 cases. The pinch graft technique took the longest time (70 days) to epithelialize sufficiently before the case could be discharged and managed easily by the owner. In comparison, 47 days were required for epithelialization after punch grafting, 34 days for tunnel grafts, and 28 days for both split- and full-thickness mesh expansion grafts.

Hair regrowth and skin pigmentation were variable with pinch and punch graft techniques. Two of the punch grafts had evidence of sparse hair. Three punch graft and two pinch graft sites were covered only by thin, hairless epithelium, with variable pigmentation. Clients noted the grafted region to be fragile and susceptible to trauma. The two tarsal wounds treated with punch grafts and one treated with pinch graft reopened and bled following return to exercise.

All of the eleven cases successfully treated with tunnel grafts (four primary grafts and seven second grafts) were considered functionally acceptable. Six cases were covered sparsely with coarse hair of variable color and texture. Clients were generally pleased with the final outcome, the exception being two show horses where cosmetic appearance was of major concern. In these cases, subsequent tunnel grafts were considered marginally acceptable.

Seven of 10 successful full-thickness mesh expansion grafts were followed from six months to four years. All cases were functionally acceptable and all were covered with haired epithelium. The hair was coarse and of different pigmentation than normal hair, but cosmetically acceptable to all clients.

Follow-up of the four successful split-thickness mesh expansion grafts found all wounds to be covered with healthy, functional epithelium. However, hair production was inconsistent, differing in both amount and quality. Two cases had sparse amounts of coarse hair cover and two cases had minimal hair cover. This was a disappointment to show-horse clients, where cosmetic appearance was important.

Discussion

The majority of the wounds in this series resulted from barbed wire entanglements of the hindlimb. There was often extensive trauma and skin loss on the dorsal surface of the tarsus and various aspects of the metatarsus. Often, severe lacerations to the tarsal, metatarsal, and metacarpal regions do not heal adequately by second intention (12,13). In addition, the scar which results from second intention healing of these large wounds is often cosmetically unappealing.

In this study, a high proportion (24/35) of the wounds to the tarsal and metatarsal regions developed pregrafting complications. Such complications involved wound infection, sequestrum formation, or exuberant granulation tissue. Such complications extended the time before grafting could take place, and contributed to additional expense in the management of these wounds. In this series of cases, 40% of the metatarsal wounds developed sequestra. Sequestrum formation may develop in situations when there is damage to the periosteum and compromised vascular supply to the cortical bone (14). Sequestrum formation should be suspected in metatarsal or metacarpal wounds that have persistent drainage, or in those wounds developing clefts or cleavage lines in the granulation tissue (13). A thorough examination, including radiographs, is important before the final preparation of the wound for grafting is undertaken.

Delays in grafting can be an important factor in the eventual success of the procedure. Minimizing the time before grafting will help ensure a more healthy, well-vascularized granulation bed (6). In experimental studies, wounds in the tarsal-metatarsal region achieve a suitable bed of granulation tissue for grafting in 14 to 21 days (5–7). This compares to the 63 day average in wounds in this series. This may account for the lower success rate as compared to experimental studies, where success rate is reported to be as high as 89% (7). As granulation tissue ages, it becomes more fibrous and less vascular (10). A reduction in vascularity will compromise the ability to revascularize the grafted tissue (10,15). This is particularly important with split- and full-thickness mesh expansion techniques where the initial fibrin adhesion and revascularization through inosculation are much more important than with the punch or tunnel graft techniques. Punch and tunnel grafts are stabilized within the granulation tissue (16,17).

Approximately 30% of the cases in this study failed on initial grafting. Failures consisted of complete sloughing of the graft in the case of split- and full-thickness mesh expansion grafts, or only partial takes with tunnel and pinch graft techniques. The dorsal aspect of the tarsus was the most difficult area to graft, and is consistent with other studies (5,7). Excessive movement in this region is likely to be one of the main reasons for failure. Such movement may explain the failure of split- and full-thickness grafts that were transferred onto what was considered to be an optimal granulation bed. Mesh expansion grafts are dependent on delicate fibrin adhesion to maintain contact with the granulation bed and allow revascularization to occur (17). This fibrin bond is disrupted easily; therefore, controlling movement of the graft will increase the success of these procedures. In our experience, a heavily padded Robert Jones bandage is most beneficial.

Most clinical and experimental reports discuss the management of wounds of a much smaller size than presented in this study (5–7,9,10). Wound size did not appear to be as important in grafting success as did granulation bed quality and wound location. The average size of the wounds that failed (135 cm^2) was much smaller than the overall average size of the 35 wounds in this study (188 cm^2). Size of the wound will influence the type of grafting procedure to be utilized, but should not be the limiting factor as to suitability for grafting. Maximizing grafting success requires appropriate decision analysis. Choice of grafting technique must be considered in terms of practicality and likelihood of long-term success.

Pinch and punch graft techniques were among the first procedures described (1,2). These procedures are

the simplest and easiest to perform but least acceptable in terms of long-term outcome. These cases required the greatest period for epithelialization, and bandaging was necessary for the entire period. The epithelial covering was thin and susceptible to trauma. Consequently, these wounds, particularly those in the tarsal region, often split and bled with exercise. Cosmetically, these grafts were the least acceptable of all procedures. These techniques are useful for practitioners who infrequently use skin grafts or those cases where the more advanced techniques are not practical or economically justified. Their limitations in terms of long-term appearance and function must be realized.

The decision to use tunnel, split-thickness, or full-thickness mesh expansion grafts depends on several factors. Both mesh expansion techniques require a high quality granulation bed that is well vascularized, free from defects, and without signs of exudate or infection. Wounds with mature granulation tissue are poor candidates for these techniques. Similarly, it was found that in some cases, prolonged treatment of wounds in preparation for grafting created a superficial infection with a persistent purulent exudate. Controlling the discharge in these sites was difficult, and a high degree of failure occurred with mesh grafting of these cases. When presented with a uniform, well-vascularized granulation bed, mesh expansion techniques were successful, particularly in the metatarsal and metacarpal regions. Both techniques resulted in rapid epithelialization of superior quality.

In our experience, hair growth with split-thickness grafts was variable and inconsistent. A lack of hair production was of concern to clients with show horses. Improvements may be possible with adjustments in the dermatome in favor of thicker sections. It has been found that optimal split thickness is 0.76 mm, but 0.63 mm is considered adequate (18). The split thickness grafts in this study were taken at 0.65 mm. In some cases, both the recipient site and donor site had poor hair regrowth, causing speculation as to the ability to consistently preserve hair follicles with split-thickness transfers. Where hair regrowth is important, full thickness transfers are the most reliable. However, one must realize that the hair will always be of a different color and pattern.

The main concerns with full-thickness mesh grafts are adequate skin availability, surgical time required for graft preparation, and management of the donor site. Wounds up to 300 cm^2 could be grafted successfully with full-thickness skin from the pectoral region. With transfers of large grafts, however, wound breakdown of the pectoral donor site frequently occurred. This was of no major consequence as all cases eventually healed by second intention. Four cases of full-thickness grafts failed for what appeared to be an inability to revascularize. It has been suggested that full thickness grafts have fewer exposed epithelial vessels, making revascularization more difficult (19). Careful dissection of the subcutaneous and adipose tissue during graft preparation is important to maximize vascular exposure.

Split-thickness grafts offer a definite advantage over full-thickness grafts in larger wounds in terms of expandability. Wounds up to 600 cm^2 were treated successfully with split-thickness mesh expansion grafts. The main challenge in the transfer of large split-thickness grafts is controlling motion of the graft at the recipient site. We advocate the use of large mattress sutures through the granulation tissue to tack the graft in place. The use of large Robert Jones-type padded bandages is also beneficial.

In situations where granulation has been prolonged, in very large wounds over mobile sites, and where topical infection is likely, we recommend the use of tunnel grafts. Cases which were initially treated unsuccessfully with expanded mesh grafts were subsequently treated successfully with tunnel grafts. Long-term results were encouraging in that the epithelium was durable and adequate for all types of performance in all cases. In general, the sparse hair growth was cosmetically acceptable to most clients, particularly pleasure-horse owners. Tunnel grafts were much easier to manage, aside from the additional anesthesia required to surgically expose the grafts (deroof) from within the granulation tissue. In situations where surgical facilities and equipment are unavailable, or where experience with mesh graft procedures is limited, tunnel grafting provides a useful alternative. The success of tunnel graft procedures is supported by a recent in-depth review and discussion of the tunnel grafting technique (4).

In summary, various wound grafting techniques are available to assist in the management of severe lower limb lacerations. Determining the most suitable technique will depend on wound location, size, quality of existing granulation tissue, cosmetic and functional expectations, surgical expertise, and equipment. Anticipating complications and ensuring a healthy pregrafting granulation bed are crucial parts of the grafting process. Treating severe lower limb lacerations can be costly. Both the veterinarian and client must thoroughly understand the temporal and financial commitment required in these challenging cases. CVJ

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A Message from the CVMA Winnipeg '91 Convention Chairman
Message du Président du congrès de l'ACV – Winnipeg '91

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The CVMA Convention in 1991 will be held in Winnipeg July 7-10. An outline of the scientific program has been inserted into the envelope of this month's **CVJ**.

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